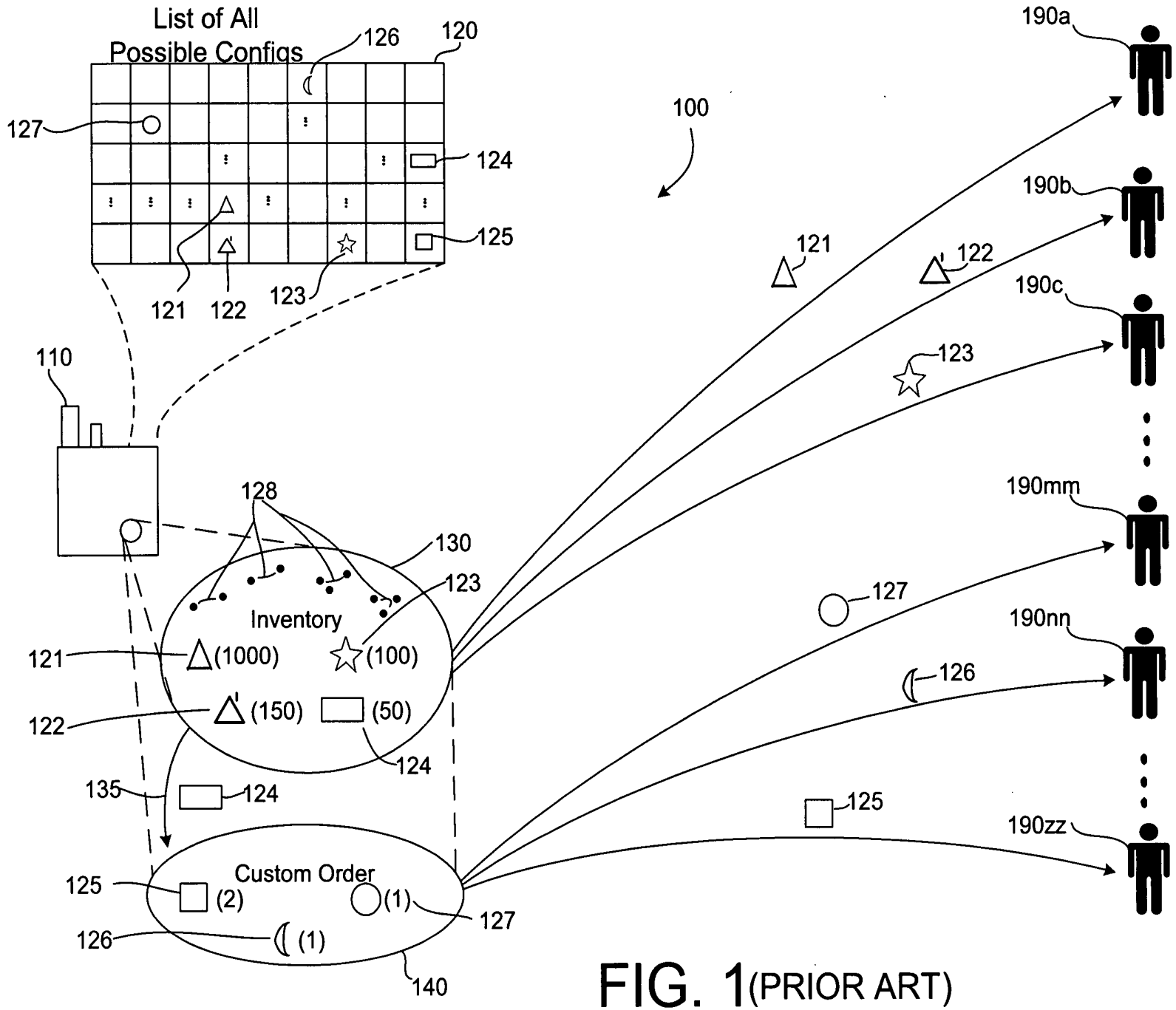


FIG. 1(PRIOR ART)

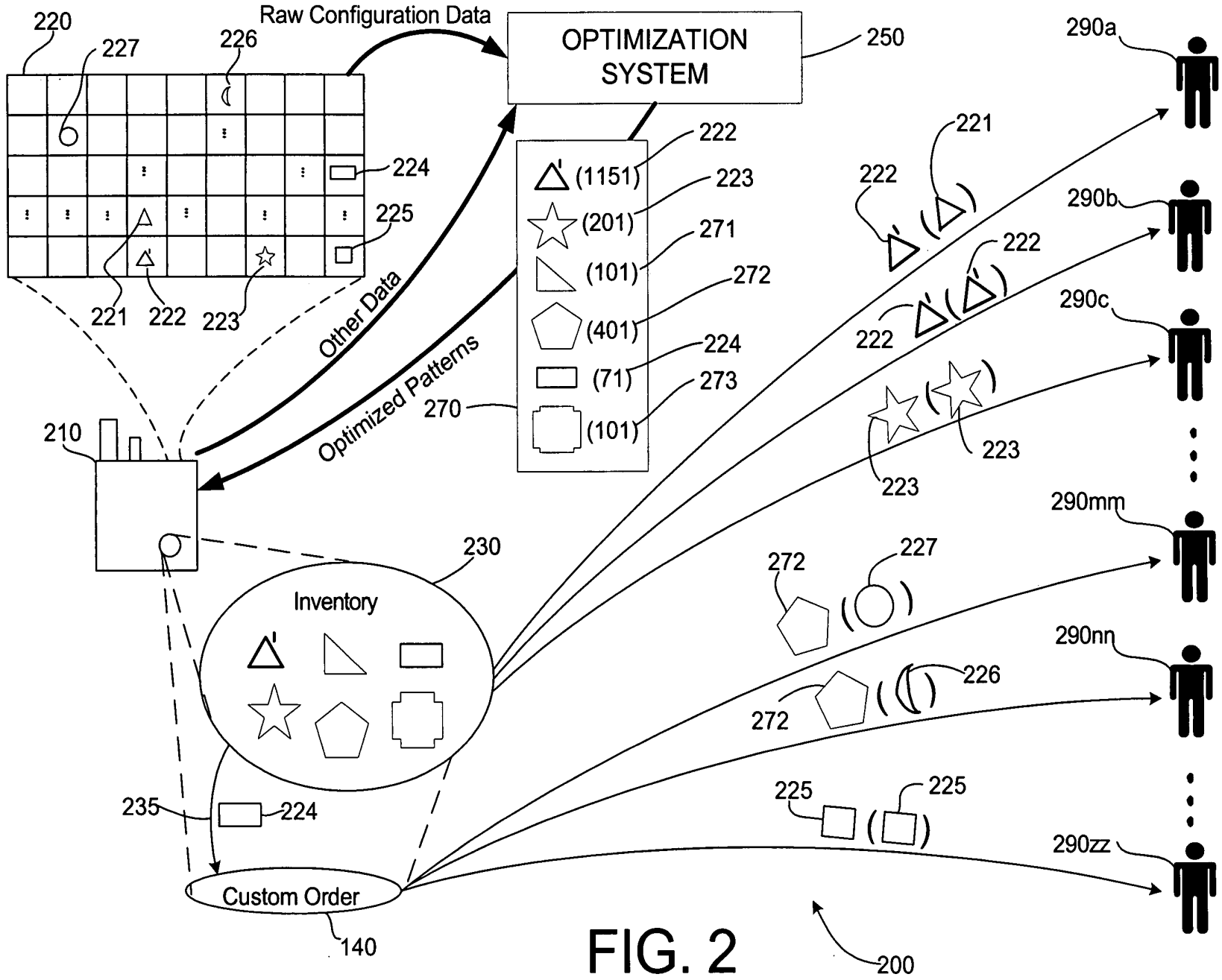

220
227
226
Raw Configuration Data
OPTIMIZATION SYSTEM
250
290a
222
221
224
(1151)
223
225
(201)
271
(101)
272
(401)
224
(71)
273
(101)
270
Other Data
Optimized Patterns
210
290b
290c
290mm
230
Inventory
290nn
235
224
Custom Order
140
290zz
200

FIG. 2

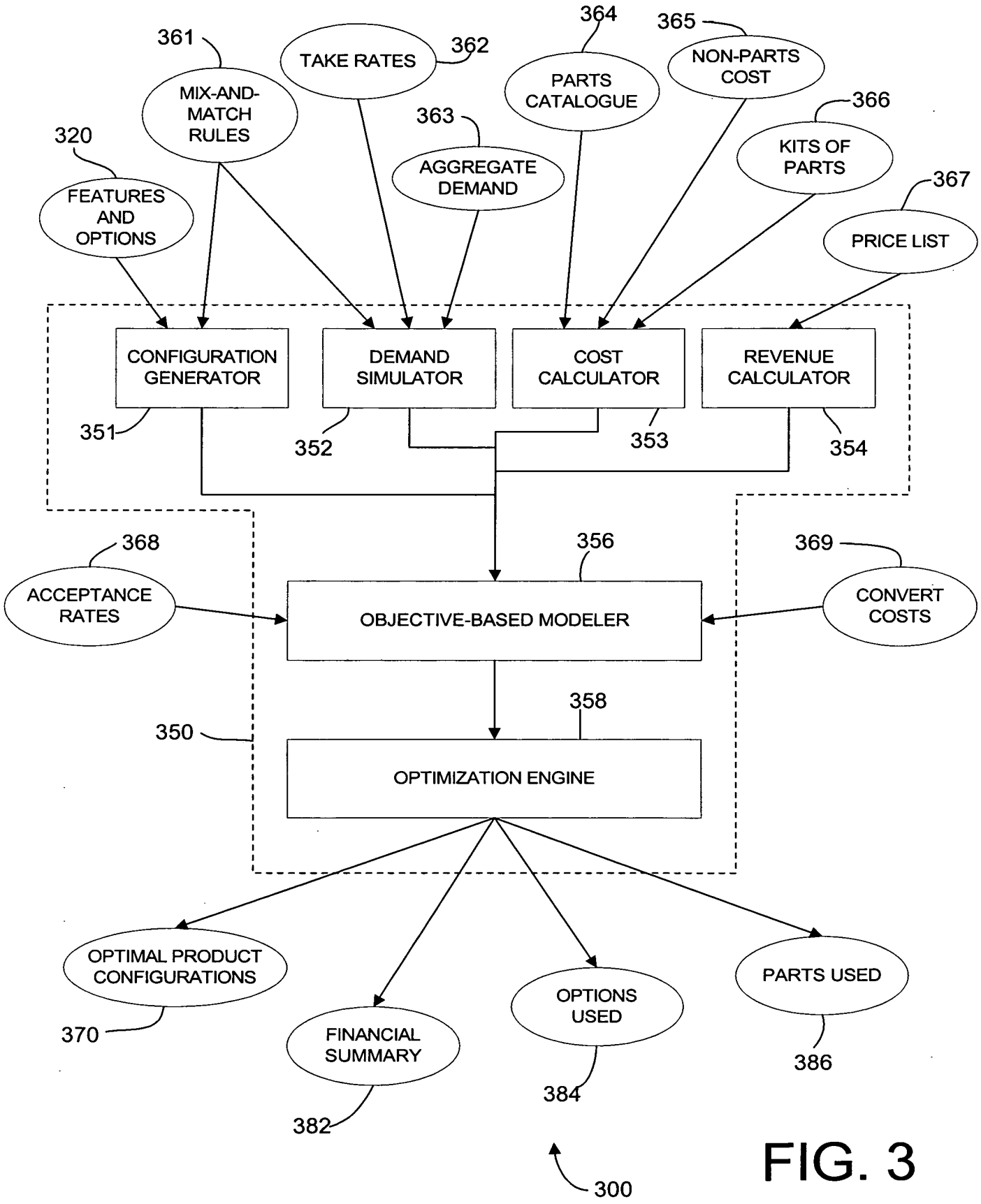

361
TAKE RATES
362
364
365
MIX-AND-MATCH RULES
PARTS CATALOGUE
NON-PARTS COST
363
366
320
AGGREGATE DEMAND
KITS OF PARTS
FEATURES AND OPTIONS
367
PRICE LIST
CONFIGURATION GENERATOR
DEMAND SIMULATOR
COST CALCULATOR
REVENUE CALCULATOR
351
352
353
354
368
356
369
ACCEPTANCE RATES
OBJECTIVE-BASED MODELER
CONVERT COSTS
358
350
OPTIMIZATION ENGINE
OPTIMAL PRODUCT CONFIGURATIONS
PARTS USED
OPTIONS USED
FINANCIAL SUMMARY
370
386
384
382
300

FIG. 3

FIG. 4

400

Index	Feature	Number of Options	Option names
1	Model	6 options	Model 1 Model 2 Model 3 Model 4 Model 5 Model 6
2	Front Axle	2 options	2 wheel drive 4 wheel drive
3	Transmission	3 options	SST PRT HST
4	ROPS - Roll over Protection system	2 options	Fixed ROPS Folding ROPS
5	PTO - Power Take off	2 options	Less PTO Mid PTO
6	SCV - System Control valve	3 options	Less- SCV Dual-SCV Triple-SCV
7	Draft-links	2 options	Less draft links Flat bar draft links
8	Hitch	2 options	None Domestic hitch
9	Tires	20 options	2 wheel drive 4005 2 wheel drive 4015 2 wheel drive 4020 2 wheel drive 4030 4 wheel drive 4500 4 wheel drive 4505 4 wheel drive 4510 4 wheel drive 4515 4 wheel drive 4520 4 wheel drive 4525 4 wheel drive 4535 4 wheel drive 4540 4 wheel drive 4545 4 wheel drive 4550 4 wheel drive 4555 4 wheel drive 4556 4 wheel drive 4560 4 wheel drive 4565 4 wheel drive 4570 4 wheel drive 4575

FIG. 5

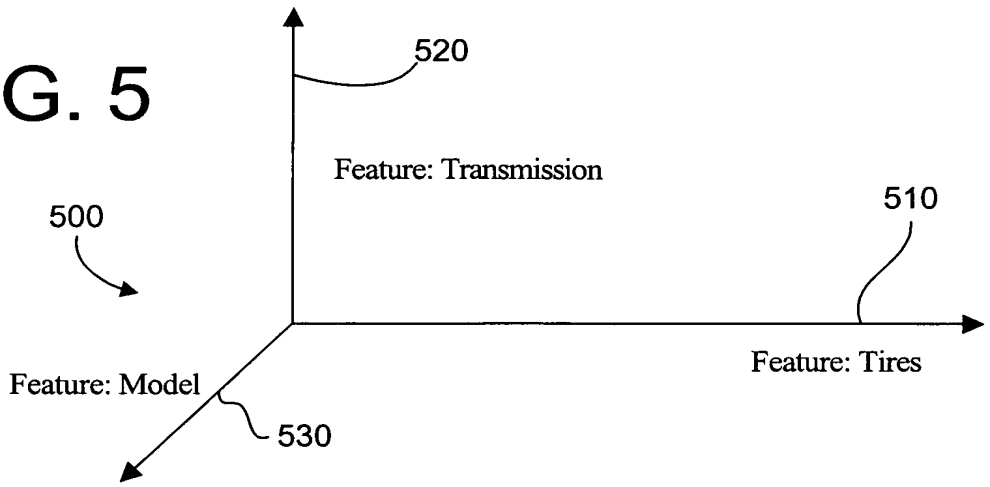

520
Feature: Transmission
500
510
Feature: Tires
Feature: Model
530

FIG. 12

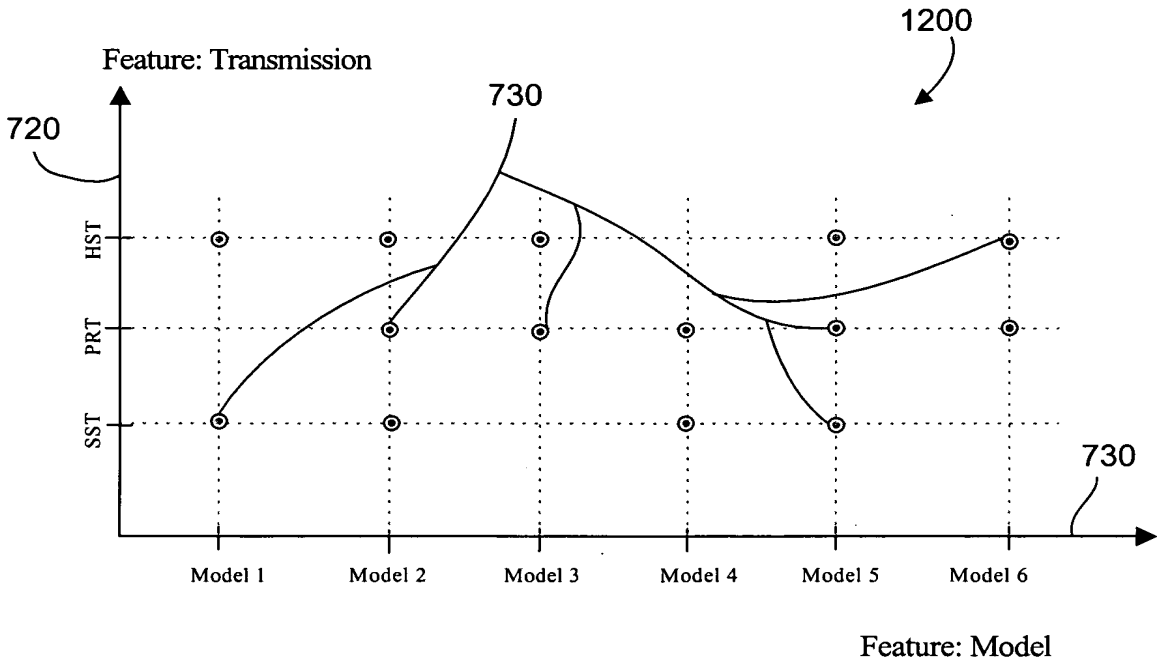

1200
Feature: Transmission
730
720
HST
PRT
SST
730
Model 1
Model 2
Model 3
Model 4
Model 5
Model 6
Feature: Model

FIG. 6

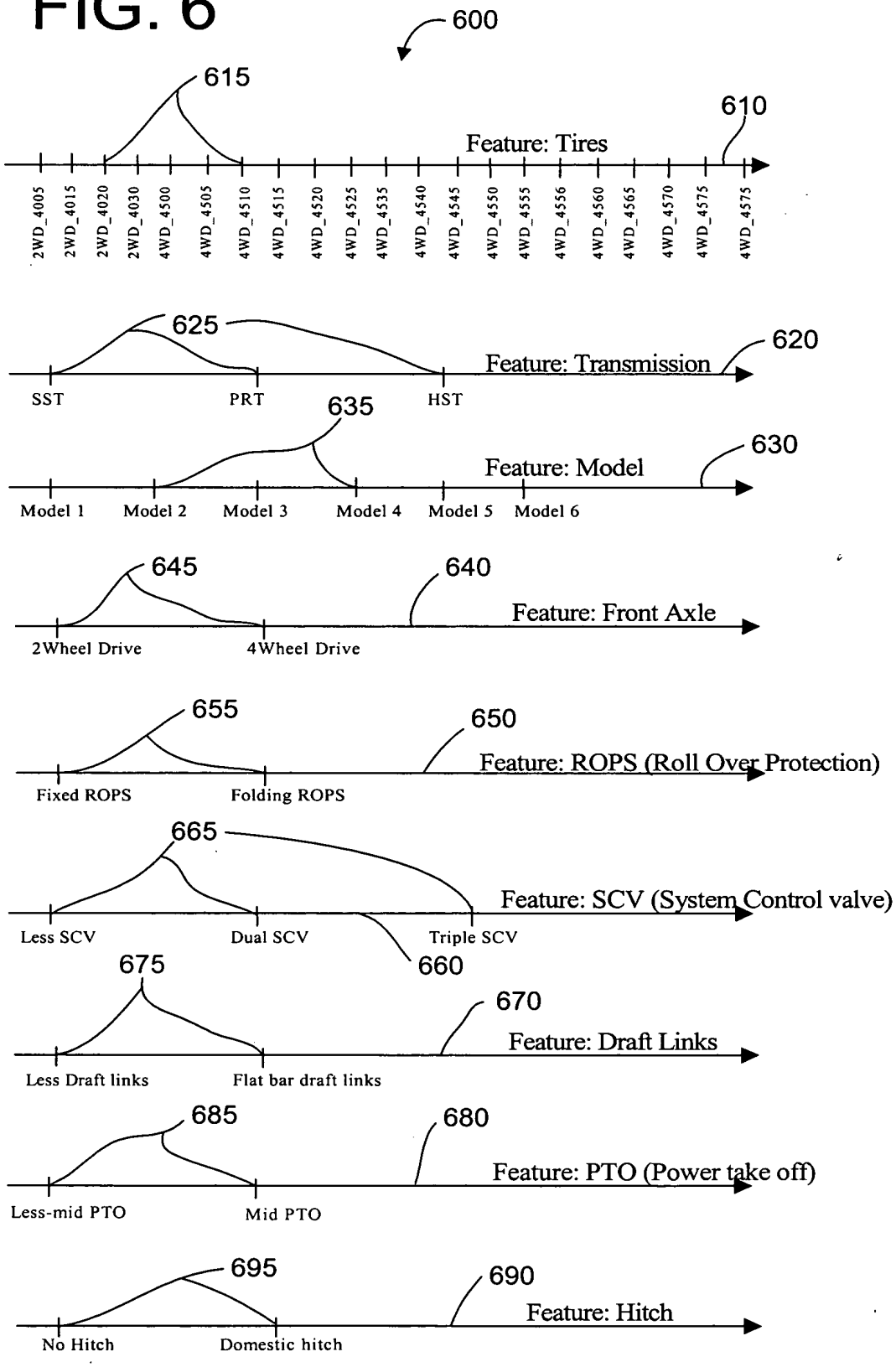

600
615
610
Feature: Tires
2WD_4005
2WD_4015
2WD_4020
2WD_4030
4WD_4500
4WD_4505
4WD_4510
4WD_4515
4WD_4520
4WD_4525
4WD_4535
4WD_4540
4WD_4545
4WD_4550
4WD_4555
4WD_4556
4WD_4560
4WD_4565
4WD_4570
4WD_4575
4WD_4575
625
620
Feature: Transmission
SST
PRT
HST
635
630
Feature: Model
Model 1
Model 2
Model 3
Model 4
Model 5
Model 6
645
640
Feature: Front Axle
2Wheel Drive
4Wheel Drive
655
650
Feature: ROPS (Roll Over Protection)
Fixed ROPS
Folding ROPS
665
Feature: SCV (System Control valve)
Less SCV
Dual SCV
Triple SCV
660
675
670
Feature: Draft Links
Less Draft links
Flat bar draft links
685
680
Feature: PTO (Power take off)
Less-mid PTO
Mid PTO
695
690
Feature: Hitch
No Hitch
Domestic hitch

FIG. 7

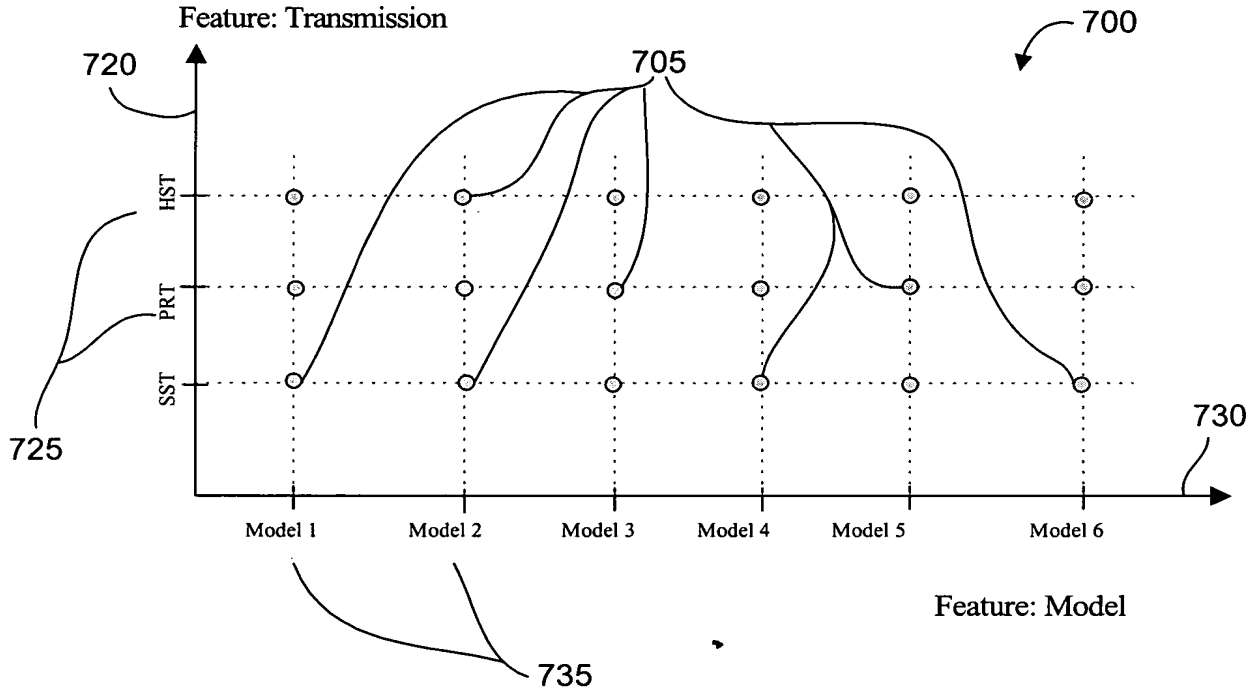

Feature: Transmission
700
720
705
HST
PRT
SST
725
730
Model 1
Model 2
Model 3
Model 4
Model 5
Model 6
Feature: Model
735

FIG. 8

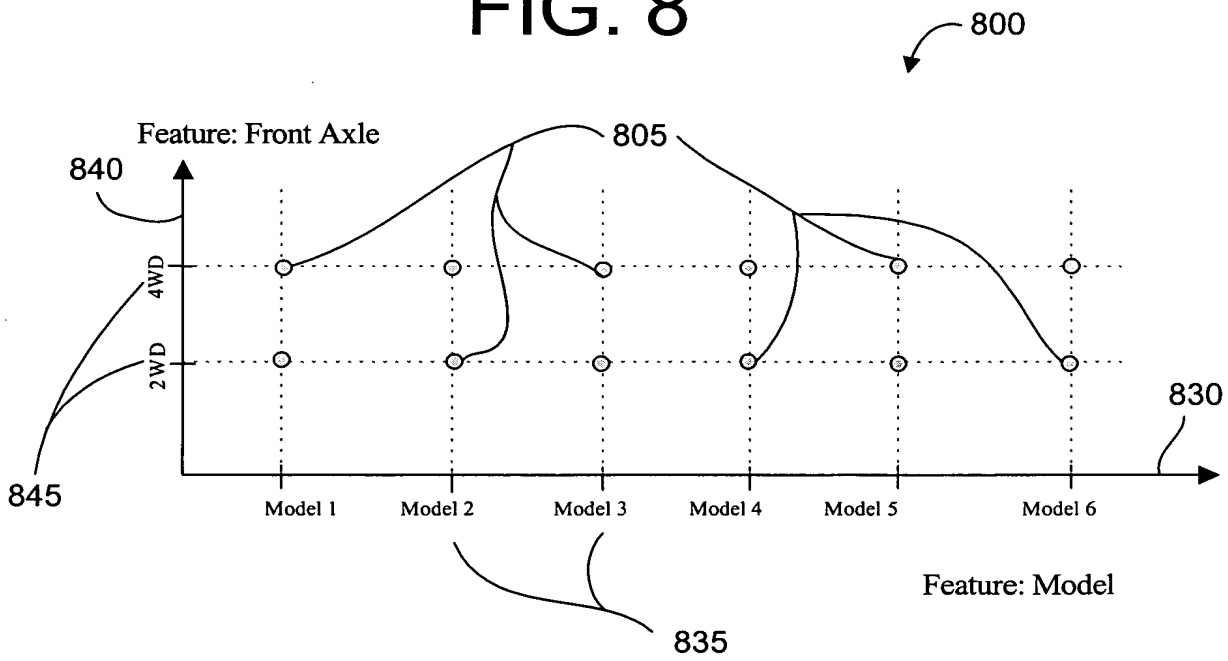

800
Feature: Front Axle
805
840
4WD
2WD
845
830
Model 1
Model 2
Model 3
Model 4
Model 5
Model 6
Feature: Model
835

FIG. 9

900

Index	Feature 1	Option 1	Relationship	Feature 2	Option 2	Translation
1	*A*	*x*	*NE*	*B*	*y*	If feature A is at option level x, then feature B cannot be at option level y
2	*A*	*x*	*EQ*	*B*	*y*	If feature A is at option level x, then feature B must be at option level y
3	*A*	*x*	*EE*	*B*	*y*	Feature A can be at option level x, if and only if feature B is at option level y
4	*A*	*x*	*OR*	*B*	*y*	If feature A is at option level x, them feature B must be at option level y or z
	A	*x*	*OR*	*B*	*z*	

FIG. 10a

1000

Model	Model_3	EQ	Front_Axle	4WD
Model	Model_6	EQ	Front_Axle	4WD
Model	Model_1	OR	Transmission	SST
Model	Model_1	OR	Transmission	HST
Model	Model_3	OR	Transmission	PRT
Model	Model_3	OR	Transmission	HST
Model	Model_4	OR	Transmission	SST
Model	Model_4	OR	Transmission	PRT
Model	Model_6	OR	Transmission	PRT
Model	Model_6	OR	Transmission	HST
Model	Model_4	NE	PTO	Mid_PTO
Model	Model_5	NE	PTO	Mid_PTO
Model	Model_6	NE	PTO	Mid_PTO
Tires	2WD_4005	EQ	Model	Model_1
Tires	2WD_4015	OR	Model	Model_1
Tires	2WD_4015	OR	Model	Model_2
Tires	2WD_4020	EQ	Model	Model_2
Tires	2WD_4030	EQ	Model	Model_4
Tires	4WD_4500	EQ	Model	Model_1
Tires	4WD_4505	OR	Model	Model_1
Tires	4WD_4510	OR	Model	Model_1
Tires	4WD_4515	OR	Model	Model_2
Tires	4WD_4520	OR	Model	Model_2
Tires	4WD_4520	OR	Model	Model_3
Tires	4WD_4525	OR	Model	Model_1

FIG. 10b 1000

Tires	4WD_4525	OR	Model	Model_2
Tires	4WD_4525	OR	Model	Model_3
Tires	4WD_4535	OR	Model	Model_2
Tires	4WD_4535	OR	Model	Model_3
Tires	4WD_4540	OR	Model	Model_4
Tires	4WD_4540	OR	Model	Model_5
Tires	4WD_4540	OR	Model	Model_6
Tires	4WD_4545	OR	Model	Model_4
Tires	4WD_4550	OR	Model	Model_5
Tires	4WD_4550	OR	Model	Model_6
Tires	4WD_4555	OR	Model	Model_4
Tires	4WD_4555	OR	Model	Model_5
Tires	4WD_4556	OR	Model	Model_6
Tires	4WD_4560	OR	Model	Model_4
Tires	4WD_4560	OR	Model	Model_5
Tires	4WD_4560	OR	Model	Model_6
Tires	4WD_4565	OR	Model	Model_4
Tires	4WD_4565	OR	Model	Model_5
Tires	4WD_4565	OR	Model	Model_6
Tires	4WD_4570	OR	Model	Model_1
Tires	4WD_4570	OR	Model	Model_2
Tires	4WD_4570	OR	Model	Model_3
Tires	4WD_4575	OR	Model	Model_2
Tires	4WD_4575	OR	Model	Model_3
Tires	2WD_4005	EQ	Front_Axle	2WD
Tires	2WD_4015	EQ	Front_Axle	2WD
Tires	2WD_4020	EQ	Front_Axle	2WD
Tires	2WD_4030	EQ	Front_Axle	2WD
Tires	4WD_4500	EQ	Front_Axle	4WD
Tires	4WD_4505	EQ	Front_Axle	4WD
Tires	4WD_4510	EQ	Front_Axle	4WD
Tires	4WD_4515	EQ	Front_Axle	4WD
Tires	4WD_4520	EQ	Front_Axle	4WD
Tires	4WD_4525	EQ	Front_Axle	4WD
Tires	4WD_4535	EQ	Front_Axle	4WD
Tires	4WD_4540	EQ	Front_Axle	4WD
Tires	4WD_4545	EQ	Front_Axle	4WD
Tires	4WD_4550	EQ	Front_Axle	4WD
Tires	4WD_4555	EQ	Front_Axle	4WD
Tires	4WD_4556	EQ	Front_Axle	4WD
Tires	4WD_4560	EQ	Front_Axle	4WD
Tires	4WD_4565	EQ	Front_Axle	4WD
Tires	4WD_4570	EQ	Front_Axle	4WD
Tires	4WD_4575	EQ	Front_Axle	4WD

FIG. 11

1100

Rule Name	Feature 1	Feature 2	Yes/No
rule1	Model	Model_1	yes
	Front_Axle	2WD	yes
	Transmission	SST	yes
	PTO	Mid_PTO	yes
rule2	Model	Model_2	yes
	Front_Axle	2WD	yes
	Transmission	SST	yes
	PTO	Mid_PTO	yes
rule3	Model	Model_4	yes
	Transmission	SST	yes
	Front_Axle	4WD	yes
rule4	Model	Model_4	yes
	Transmission	PRT	yes
	Front_Axle	2WD	yes
rule5	Model	Model_5	yes
	Transmission	SST	yes
	Front_Axle	4WD	yes
rule6	Model	Model_5	yes
	Transmission	PRT	yes
	Front_Axle	2WD	yes
rule7	Model	Model_5	yes
	Transmission	HST	yes
	Front_Axle	2WD	yes
rule8	Model	Model_2	yes
	Transmission	PRT	yes
	Front_Axle	2WD	yes

FIG. 13

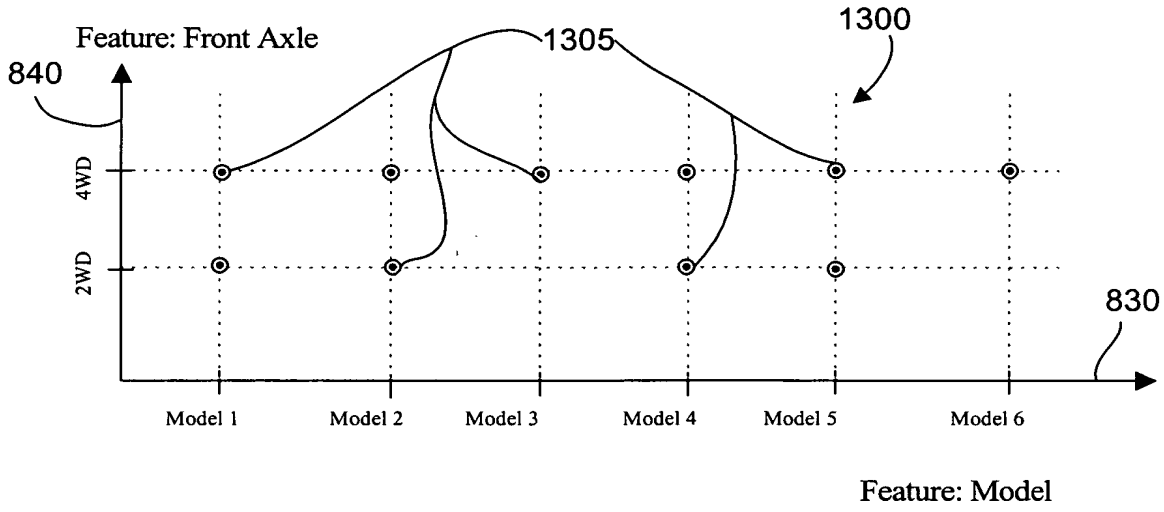

Feature: Front Axle
840
1305
1300
4WD
2WD
830
Model 1
Model 2
Model 3
Model 4
Model 5
Model 6
Feature: Model

FIG. 34

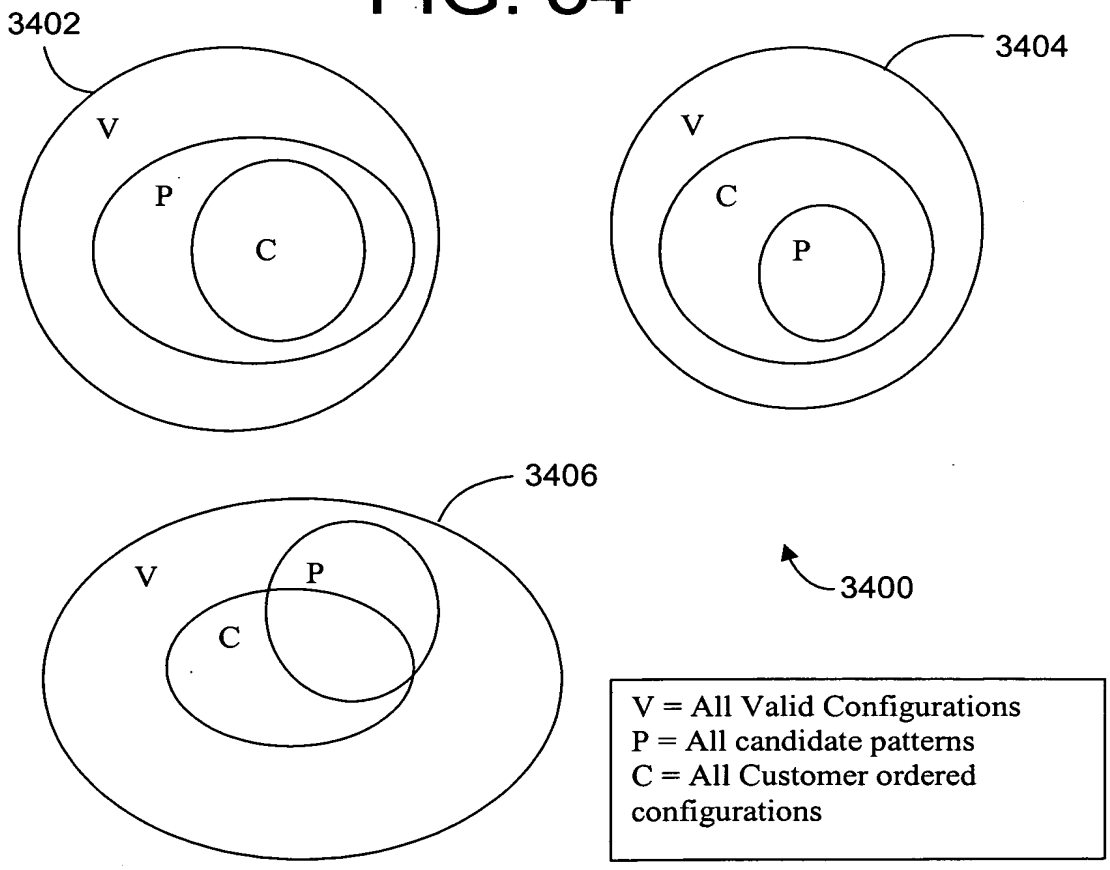

3402
V
P
C
3404
V
C
P
3406
V
P
C
3400
V = All Valid Configurations
P = All candidate patterns
C = All Customer ordered configurations

FIG. 14 1400

Part number	Quantity required
YZ18125	1
LVA11680	1
LVU12736	1
M137828	2
14M7298	2
19M7867	2
LVA11219	1
LVA11349	1
LVA11542	1
LVA11543	1

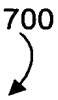
FIG. 15 1500

Part number	Unit cost
14M7298	0.02
19M7867	0.05
LVA11219	3.47
LVA11349	4.52
LVA11542	3.72
LVA11543	2.90
LVA11680	5.32
LVU12736	6.52
M137828	0.11
YZ18125	2805.62

FIG. 16 1600

Kit	Mask	Feature	Option	Y/N
KIT276	1	Transmission	SST	Yes
KIT276	1	Model	Model_1	Yes
KIT276	1	Front_Axle	4WD	Yes
KIT276	1	PTO	Mid_PTO	No
KIT276	2	Transmission	SST	Yes
KIT276	2	Model	Model_2	Yes
KIT276	2	Front_Axle	4WD	Yes
KIT276	2	PTO	Mid_PTO	No

FIG. 17



Feature	Option	1	2	3	4	5	6
Model	Model_1	15169	0	0	0	0	0
Model	Model_2	0	16339	0	0	0	0
Model	Model_3	0	0	19359	0	0	0
Model	Model_4	0	0	0	21279	0	0
Model	Model_5	0	0	0	0	22939	0
Model	Model_6	0	0	0	0	0	24709
Front_Axle	2WD	-1110	-1110	0	-1850	-2235	0
Front_Axle	4WD	0	0	0	0	0	0
Transmission	SST	0	0	0	-1200	-1200	0
Transmission	PRT	0	1200	0	0	0	0
Transmission	HST	2400	2400	1200	0	1200	1200
ROPS	Fixed	-170	-170	-170	-170	-170	-170
ROPS	Folding	0	0	0	0	0	0
PTO	Mid_PTO	390	390	390	0	0	0
SCV	Dual	700	700	700	700	700	700
SCV	Triple	950	950	950	950	950	950
Draft_Links	Less	-700	-700	-700	-630	-630	-630
Draft_Links	Flat_Bar	0	0	0	0	0	0
Hitch	Domestic	220	220	220	220	220	220
Tires	2WD_4005	90	0	0	0	0	0
Tires	2WD_4015	0	-95	0	0	0	0
Tires	2WD_4020	0	15	0	0	0	0
Tires	2WD_4030	0	0	0	-150	0	0
Tires	4WD_4500	0	0	0	0	0	0
Tires	4WD_4505	90	0	0	0	0	0
Tires	4WD_4510	210	0	0	0	0	0
Tires	4WD_4515	0	200	200	0	0	0
Tires	4WD_4520	0	400	400	0	0	0
Tires	4WD_4525	95	0	0	0	0	0
Tires	4WD_4535	0	220	220	0	0	0
Tires	4WD_4540	0	0	0	365	180	170
Tires	4WD_4545	0	0	0	0	0	0
Tires	4WD_4550	0	0	0	0	10	0
Tires	4WD_4555	0	0	0	185	0	0
Tires	4WD_4556	0	0	0	0	0	128
Tires	4WD_4560	0	0	0	595	410	400
Tires	4WD_4565	0	0	0	1610	1425	1415
Tires	4WD_4570	1295	1200	1200	0	0	0
Tires	4WD_4575	0	450	450	0	0	0

FIG. 18 1800

Model	Model_1	0.1391
Model	Model_2	0.3325
Model	Model_3	0.2034
Model	Model_4	0.0855
Model	Model_5	0.1034
Model	Model_6	0.1361

FIG. 19 1900

		Model					
Feature	**Option**	**1**	**2**	**3**	**4**	**5**	**6**
Front_Axle	2WD	0.0500	0.0370	0.0000	0.0520	0.0180	0.0000
Front_Axle	4WD	0.9500	0.9630	1.0000	0.9480	0.9820	1.0000
Transmission	SST	0.2060	0.0870	0.0000	0.0520	0.0180	0.0000
Transmission	PRT	0.0000	0.2460	0.1860	0.9480	0.4510	0.4270
Transmission	HST	0.7940	0.6670	0.8140	0.0000	0.5310	0.5730
ROPS	Fixed	0.3210	0.2270	0.1810	0.1600	0.1360	0.0820
ROPS	Folding	0.6790	0.7730	0.8190	0.8400	0.8640	0.9180
PTO	Less_PTO	0.5130	0.7340	0.5860	1.0000	1.0000	1.0000
PTO	Mid_PTO	0.4870	0.2660	0.4140	0.0000	0.0000	0.0000
SCV	Less_SCV	0.0660	0.0610	0.0180	0.0450	0.0180	0.0160
SCV	Dual_SCV	0.8450	0.8360	0.8590	0.8930	0.8320	0.8130
SCV	Triple_SCV	0.0890	0.1030	0.1230	0.0620	0.1500	0.1710
Draft_Links	Less_Draft	0.0020	0.0040	0.0040	0.0370	0.0130	0.0297
Draft_Links	Flat_Bar	0.9980	0.9960	0.9960	0.9630	0.9870	0.9703
Hitch	Domestic	0.0240	0.0500	0.0600	0.0450	0.0270	0.0570
Tires	2WD_4005	0.0420	0.0000	0.0000	0.0000	0.0000	0.0000
Tires	2WD_4015	0.0080	0.0260	0.0000	0.0000	0.0000	0.0000
Tires	2WD_4020	0.0000	0.0150	0.0000	0.0000	0.0000	0.0000
Tires	2WD_4030	0.0000	0.0000	0.0000	0.0518	0.0323	0.0000
Tires	4WD_4500	0.0260	0.0000	0.0000	0.0000	0.0000	0.0000
Tires	4WD_4505	0.3570	0.0000	0.0000	0.0000	0.0000	0.0000
Tires	4WD_4510	0.4840	0.0000	0.0000	0.0000	0.0000	0.0000
Tires	4WD_4515	0.0000	0.6030	0.5840	0.0000	0.0000	0.0000
Tires	4WD_4520	0.0000	0.1550	0.2560	0.0000	0.0000	0.0000
Tires	4WD_4525	0.0800	0.0600	0.0370	0.0000	0.0000	0.0000
Tires	4WD_4535	0.0000	0.1090	0.0740	0.0000	0.0000	0.0000
Tires	4WD_4540	0.0000	0.0000	0.0000	0.0755	0.1885	0.1533
Tires	4WD_4545	0.0000	0.0000	0.0000	0.1238	0.0000	0.0000
Tires	4WD_4550	0.0000	0.0000	0.0000	0.0000	0.0865	0.0853
Tires	4WD_4555	0.0000	0.0000	0.0000	0.1445	0.1113	0.0000
Tires	4WD_4556	0.0000	0.0000	0.0000	0.0000	0.0000	0.1023
Tires	4WD_4560	0.0000	0.0000	0.0000	0.6028	0.5680	0.6260
Tires	4WD_4565	0.0000	0.0000	0.0000	0.0018	0.0135	0.0333
Tires	4WD_4570	0.0030	0.0030	0.0160	0.0000	0.0000	0.0000
Tires	4WD_4575	0.0000	0.0290	0.0330	0.0000	0.0000	0.0000

FIG. 20

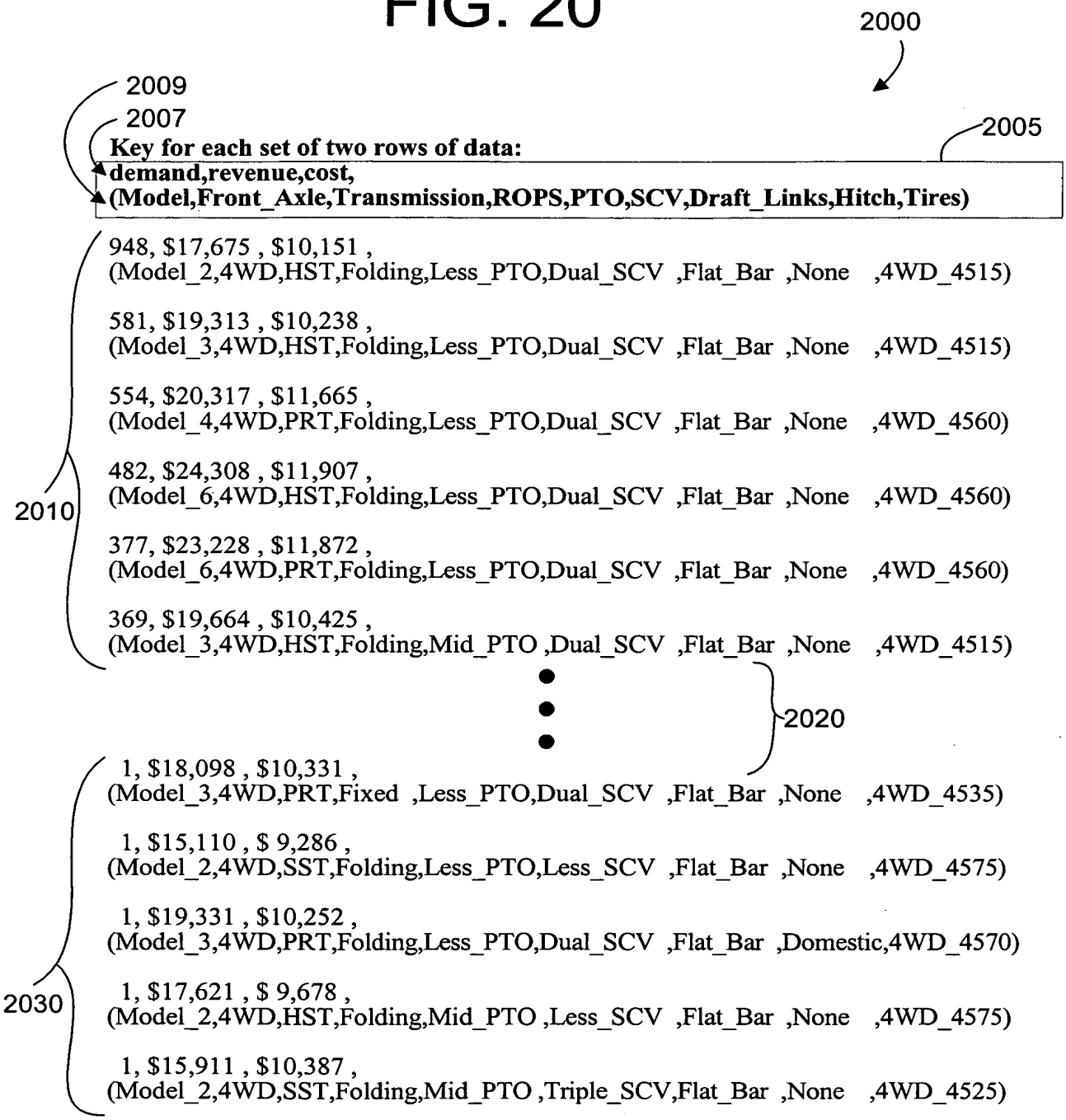

2000
2009
2007
2005
Key for each set of two rows of data:
demand,revenue,cost,
(Model,Front_Axle,Transmission,ROPS,PTO,SCV,Draft_Links,Hitch,Tires)
948, $17,675 , $10,151 ,
(Model_2,4WD,HST,Folding,Less_PTO,Dual_SCV ,Flat_Bar ,None ,4WD_4515)
581, $19,313 , $10,238 ,
(Model_3,4WD,HST,Folding,Less_PTO,Dual_SCV ,Flat_Bar ,None ,4WD_4515)
554, $20,317 , $11,665 ,
(Model_4,4WD,PRT,Folding,Less_PTO,Dual_SCV ,Flat_Bar ,None ,4WD_4560)
482, $24,308 , $11,907 ,
(Model_6,4WD,HST,Folding,Less_PTO,Dual_SCV ,Flat_Bar ,None ,4WD_4560)
2010
377, $23,228 , $11,872 ,
(Model_6,4WD,PRT,Folding,Less_PTO,Dual_SCV ,Flat_Bar ,None ,4WD_4560)
369, $19,664 , $10,425 ,
(Model_3,4WD,HST,Folding,Mid_PTO ,Dual_SCV ,Flat_Bar ,None ,4WD_4515)
2020
1, $18,098 , $10,331 ,
(Model_3,4WD,PRT,Fixed ,Less_PTO,Dual_SCV ,Flat_Bar ,None ,4WD_4535)
1, $15,110 , $ 9,286 ,
(Model_2,4WD,SST,Folding,Less_PTO,Less_SCV ,Flat_Bar ,None ,4WD_4575)
1, $19,331 , $10,252 ,
(Model_3,4WD,PRT,Folding,Less_PTO,Dual_SCV ,Flat_Bar ,Domestic,4WD_4570)
2030
1, $17,621 , $ 9,678 ,
(Model_2,4WD,HST,Folding,Mid_PTO ,Less_SCV ,Flat_Bar ,None ,4WD_4575)
1, $15,911 , $10,387 ,
(Model_2,4WD,SST,Folding,Mid_PTO ,Triple_SCV,Flat_Bar ,None ,4WD_4525)

FIG. 21 2100

UPGRADE	L ss_SCV	Dual_SCV	Triple_SCV
Less_SCV	1	0	0
Dual_SCV	1	1	0
Triple_SCV	1	1	1

FIG. 22 2200

UPGRADE	SST	PRT	HST
SST	1	0	0
PRT	0	1	0
HST	0	0	1

FIG. 23 2300

CONVERT	SST	PRT	HST
SST	1	0	0
PRT	0	1	0
HST	0	0	1

FIG. 24 2400

CONVERT cost	SST	PRT	HST
SST	0	INF	INF
PRT	INF	0	INF
HST	INF	INF	0

FIG. 25 2500

ACCEPT probability	SST	PRT	HST
SST	1	0 - (2504)	0
PRT	0.4 - (2502)	1	0.2
HST	0	0.2	1

FIG. 26 2600

UPGRADE	Less_PTO	Mid_PTO
Less_PTO	1	0
Mid_PTO	1	1

FIG. 27 2700

UPGRADE	Less_Draft_Links	Flat_Bar_Draft_Links
Less_Draft _Links	1	0
Flat_Bar_Draft_Links	1	1

FIG. 28 2800

ACCEPT probability	2WD	4WD
2WD	1	0.2
4WD	0.5	1

FIG. 29 2900

ACCEPT probability	Fixed_ROPS	Folding_ROPS
Fixed_ROPS	1	0.5
Folding_ROPS	0.95	1

FIG. 30 3000

ACCEPT probability	Less_PTO	Mid_PTO
Less_PTO	1	0.5
Mid_PTO	0.5	1

FIG. 31 3100

ACCEPT probability	Less_SCV	Dual_SCV	Triple_SCV
Less_SCV	1	0.375	0
Dual_SCv	0.25	1	0.85
Triple_SCV	0.25	0.375	1

FIG. 32 3200

ACCEPT probability	Less_Draft_Links	Flat_Bar_Draft_Links
Less_Draft_Links	1	0
Flat_Bar_Draft_Links	0.95	1

FIG. 33 3300

ACCEPT probability	None	Domestic_Hitch
None	1	0.8
Domestic_Hitch	0.5	1

FIG. 35 3500

d(i) = the demand for configuration i in units, where i is in C.

convert(i,j) = cost of converting from pattern j to configuration i, where i is in C and j is in COMPETE(i).

prob(i,j) = probability that a customer who wants configuration i will accept pattern j, where i is in C and j is in COMPETE(i).

c(i,j) = cost per unit if configuration i is assigned to pattern j, where i is in C and j is in COMPETE(i).

r(i,j) = revenue per unit if configuration i is assigned to pattern j, where i is in C and j is in COMPETE(i).

x(i,j) = 1 if configuration i is assigned to pattern j in the solution;
0 otherwise,
where i is in C, and j is in COMPETE(i).

y(j) = 1 if pattern j is chosen as a winner in the solution;
0 otherwise,
where j is in P.

FIG. 36

3600

MODEL (P1)

Maximize the Objective Function Over x and y:

$$\sum_{i \in C} \sum_{j \in COMPETE(i)} d(i) * (r(i,j) - c(i,j)) * x(i,j)$$ 3605

Subject to:

Constraint Set 1:

$$\sum_{j \in COMPETE(i)} x(i,j) \leq 1$$ 3610

For i in C,

Constraint Set 2:

$$x(i,j) \leq y(j)$$ 3620

For i in C, j in COMPLETE(i)

Constraint Set 3:

$$\sum_{j \in P} y(j) \leq r$$ 3630

FIG. 37

3700

MODEL (P2)

Maximize the Objective Function Over x and y: 3705

$$\sum_{i \in C} \sum_{j \in COMPETE(i)} d(i) * (r(i,j) - c(i,j)) * x(i,j) - G * (r-1)$$

Subject to:

Constraint Set 1:

$$\sum_{j \in COMPETE(i)} x(i,j) \leq 1$$ 3710

For i in C,

Constraint Set 2:

$$x(i,j) \leq y(j)$$ 3720

For i in C, j in COMPLETE(i)

Constraint Set 3:

$$\sum_{j \in P} y(j) - r = 0$$ 3730

FIG. 38

3800

MODEL (LP2)

Maximize the Objective Function Over x, y and r: 3805

$$\sum_{i \in C} \sum_{j \in COMPETE(i)} d(i) * (r(i,j) - c(i,j)) * x(i,j) - G * (r-1)$$

Subject to:

Constraint Set 1:

$$\sum_{j \in COMPETE(i)} x(i,j) \leq 1 \qquad 3810$$

For i in C,

Constraint Set 2:

$$x(i,j) \leq y(j) \qquad 3820$$

For i in C, j in COMPLETE(i)

Constraint Set 3:

$$\sum_{j \in P} y(j) = r \qquad 3830$$

Constraint Set 4:

$$0 \leq x(i,j) \leq 1 \qquad 3840$$

For i in C, j in COMPLETE(i)

Constraint Set 5:

$$0 \leq y(j) \leq 1 \qquad 3850$$

For j in P.

FIG. 39

3900

Lagrangian Function

$$L(\pi) = \max(x, y, r) \sum_{i \in C} \sum_{j \in COMPETE(i)} d(i) * (r(i,j) - c(i,j)) * x(i,j)$$

$$- G * (r - 1) + \sum_{i \in C} \pi(i) * (1 - \sum_{j \in COMPETE\ (i)} x(i,j))$$

3905

Subject to:

Constraint Set 1:

$$x(i,j) \leq y(j)$$

3910

For i in C, j in COMPLETE(i)

Constraint Set 2:

$$\sum_{j \in P} y(j) - r = 0$$

3920

Constraint Set 3:

$$0 \leq x(i,j) \leq 1$$

3930

For i in C, j in COMPLETE(i)

Constraint Set 4:

$$0 \leq y(j) \leq 1$$

3940

For j in P.

FIG. 40

4000

Lagrangian Function - simplified

$$L(\pi) = G + \sum_{i \in C} \pi(i) + \max(\ x, y, r)$$

$$\sum_{i \in C} \sum_{j \in COMPETE(i)} (d(i) * r(i,j) - d(i) * c(i,j) - \pi(i)) * x(i,j)$$

4005

Subject to:

Constraint Set 1:

$$x(i,j) \leq y(j)$$

4010

For i in C, j in COMPLETE(i)

Constraint Set 2:

$$\sum_{j \in P} y(j) - r = 0$$

4020

Constraint Set 3:

$$0 \leq x(i,j) \leq 1$$

4030

For i in C, j in COMPLETE(i)

Constraint Set 4:

$$0 \leq y(j) \leq 1$$

4040

For j in P.

4100

FIG. 41

MODEL (D2)

$$\min(\pi \geq 0) L(\pi)$$

4200

FIG. 42

$$\sigma_j(\pi) = \sum_{i \in CAPTURE(j)} \max\{d(i) * r(i,j) - d(i) * c(i,j) - \pi(i), 0\}$$

4300

FIG. 43

$$P^* = \{ j \in P \mid \sigma_j(\pi) >= G \}$$

$$r^* = number\_of\_elements(P^*)$$

4400

FIG. 44

$$L(\pi) = G + \sum_{i \in C} \pi(i) + \sum_{j \in P^*} \sigma_j(\pi) - G * r^*$$

4500

FIG. 45

$$\pi_i^{k+1} = \pi_i^k - \lambda^k * (1 - \sum_{j \in COMPETE(i)} x^*(i,j))$$

For all i in C

FIG. 46

4600

$$x^*(i,j)=1 \quad \text{IF} \quad d(i)*r(i,j)-d(i)*c(i,j)-\pi(i)>0$$

$$x^*(i,j)=0 \quad \text{IF} \quad d(i)*r(i,j)-d(i)*c(i,j)-\pi(i)\leq 0$$

$$y^*(j)=1 \quad \text{IF} \quad \sigma_j(\pi)\geq G$$

$$y^*(j)=0 \quad \text{IF} \quad \sigma_j(\pi)<G$$

FIG. 47

4700

Step 0: Set t=0, and choose P(t) as a subset of V.

Step 1: Solve (P2(t)) to get a solution.

$$(x^t, y^t, \pi^t)$$

4710

4720

Step 2: Find a pattern k in (V - P) such that:

$$\sigma_k(\pi^t)=\sum_{i\in CAPTURE(k)}\max\{d(i)*r(i,k)-d(i)*c(i,k)-\pi^t(i),0\}\geq G$$

If there is no such pattern k, then we are done.

Step 3: Set P(t+1) = P(t) + {k}. Set t=t+1. Go to step 1.

FIG. 48

Winning Pattern	Production	Revenu	Cost	Configuration
Pattern # 151	347.34375 units	$14,822	$9,770	Model_1,4WD,SST,Folding,Mid_PTO,Dual_SCV, Flat_Bar,None,4WD_4510

4804

4800

FIG. 49

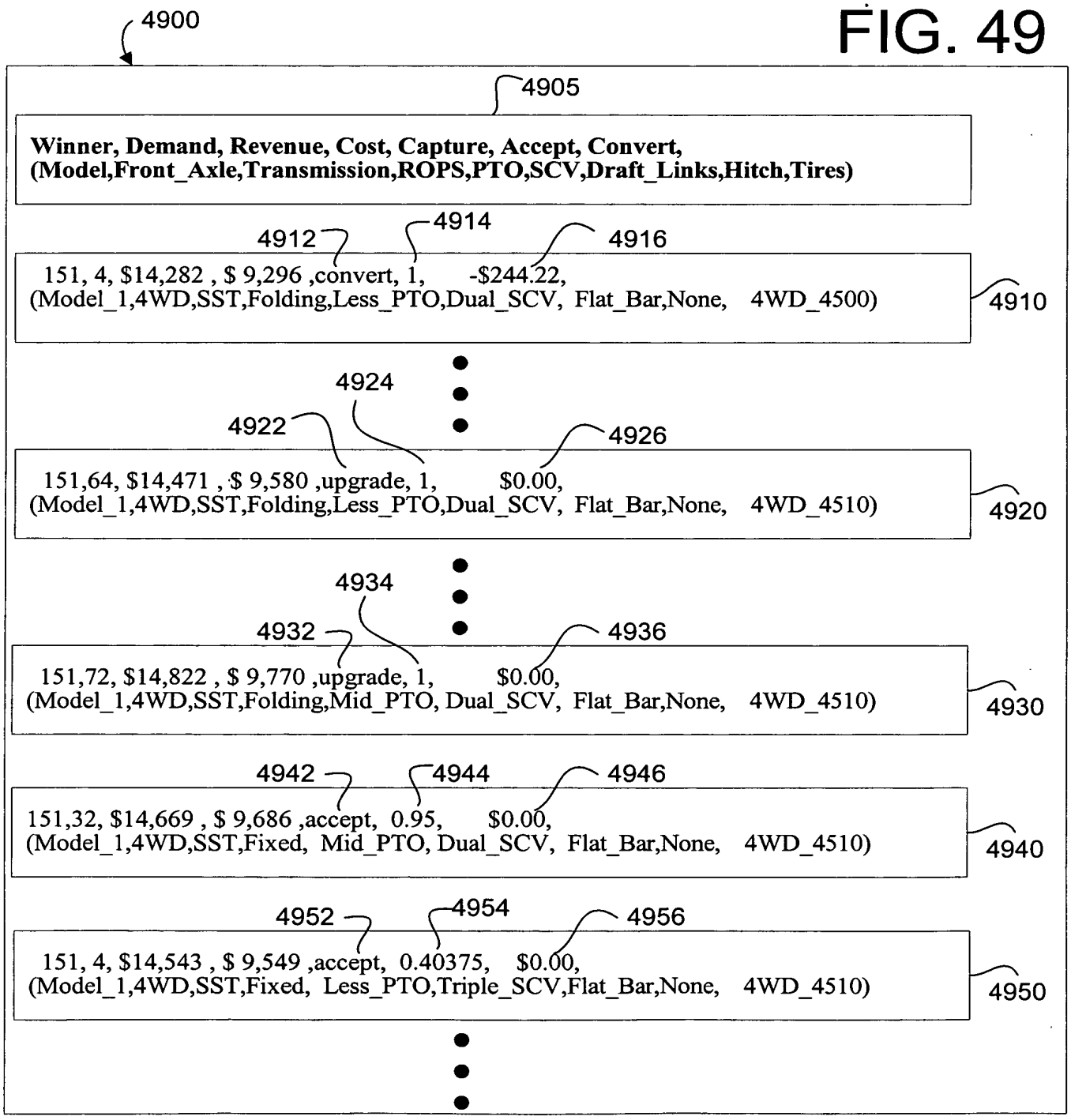
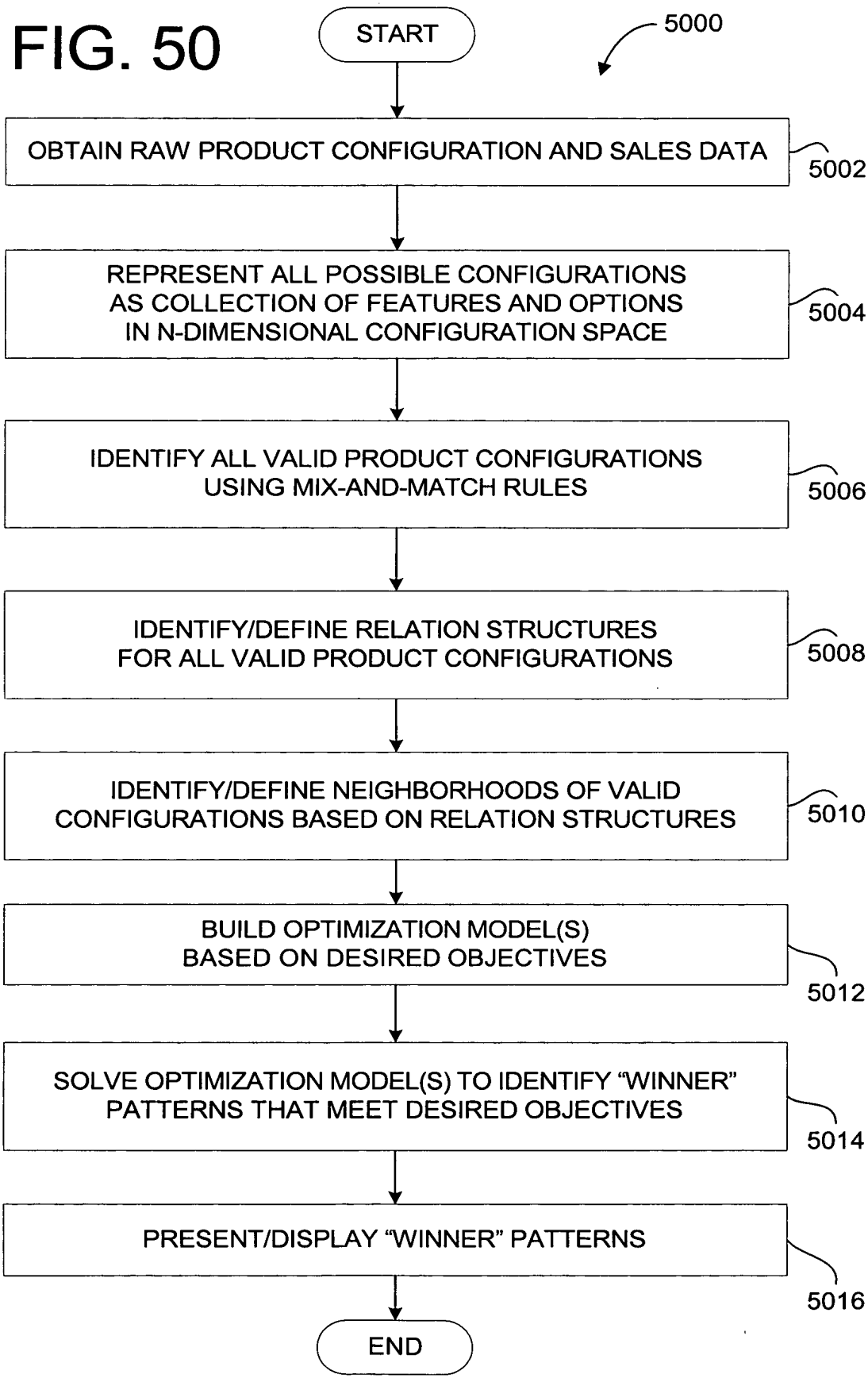


FIG. 50


START
5000
OBTAIN RAW PRODUCT CONFIGURATION AND SALES DATA
5002
REPRESENT ALL POSSIBLE CONFIGURATIONS AS COLLECTION OF FEATURES AND OPTIONS IN N-DIMENSIONAL CONFIGURATION SPACE
5004
IDENTIFY ALL VALID PRODUCT CONFIGURATIONS USING MIX-AND-MATCH RULES
5006
IDENTIFY/DEFINE RELATION STRUCTURES FOR ALL VALID PRODUCT CONFIGURATIONS
5008
IDENTIFY/DEFINE NEIGHBORHOODS OF VALID CONFIGURATIONS BASED ON RELATION STRUCTURES
5010
BUILD OPTIMIZATION MODEL(S) BASED ON DESIRED OBJECTIVES
5012
SOLVE OPTIMIZATION MODEL(S) TO IDENTIFY "WINNER" PATTERNS THAT MEET DESIRED OBJECTIVES
5014
PRESENT/DISPLAY "WINNER" PATTERNS
5016
END